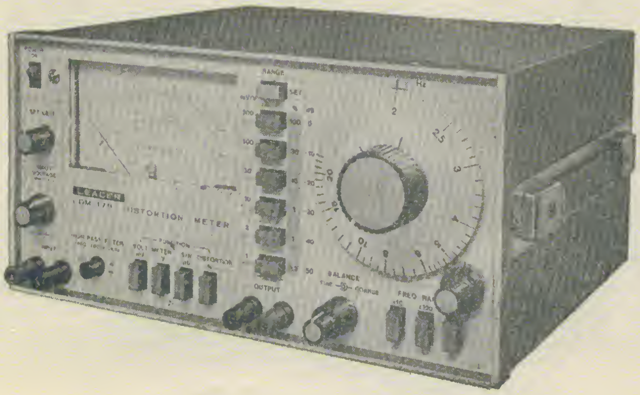
LEADER TEST INSTRUMENTS

MODEL LDM-170

DISTORTION METER

OPERATING INSTRUCTIONS



LEADER ELECTRONICS CORP.

CONTENTS

SECTION				PAGE
1	DESCRIPTION			
	1.1	General		2
	1.2	Specifications		2
	1.3	Panel Functions		3
2	OPERATION			
	2.1	Distortion Measurement		
		2.1.1	Preliminary Notes	4
		2.1.2	Preparation	5
		2.1.3	Tuning and Balancing Adjustments	6
		2.1.4	Measurements at 0.1 – 300mVrms input	7
		2.1.5	Use of an Oscilloscope	8
		2.1.6	Examples of Measurements	10
	2.2	S/N Measurement		12
	2.3	Voltage Measurement		
		2.3.1	General	13
		2.3.2	Operation	14
3	PRINCIPLE OF OPERATION			
	3.1	Distortion Measurement		15
	3.2	S/N Measurement		16
	3.3	Voltage Measurement		17
	3.4	High-pass Filter		18
	3.5	DC Power Supply		18
4	MAINTENANCE			
	4.1	General		18
	4.2	Cover Removal		18
	4.3	Circuit Adjustments		
		4.3.1	Location of Adjusters	18
		4.3.2	Test Equipment Required	19
		4.3.3	Checks and Adjustments	19

OPERATING INSTRUCTIONS

SECTION 1 DESCRIPTION

1.1 General

The LDM-170 measures the distortion, S/N (signal-to-noise ratio), and signal levels in audio frequency circuits.
A highly selective balancing network is used to eliminate the fundamental frequency in the 20Hz to 20kHz ba
The distortion products are fed to a stable high-gain wideband amplifier for indication on the meter. The amplif
is effective up to 200kHz and measurements are possible up to and including the tenth harmonic of 20kHz.
The balancing network is switched out when measuring the noise and signal levels whereby the high-gain amplif
is used as a sensitive voltmeter.
S/N can be measured to 70dB below the reference level. In addition, signal levels in the 100μV to 300V ra
can be measured for frequencies between 20Hz and 200kHz.
Output terminals are provided for scope connections when observing the distortion components and/or noise.

1.2 Specifications

Distortion Measurement	
Range	0.3%, 1%, 3%, 10%, 30% and 100% full scale.
Accuracy	±5% of full scale, at 30% and lower ranges.
Frequency Range	20Hz to 20kHz (fundamental) in three bands; calibration accuracy within ± balancing controls provided.
Input Voltage Range	0.35 to 30Vrms.
Input Impedance	Approx. 100kΩ; less than 50pF in shunt.
Fundamental Suppression	Over 70dB.
Residual Distortion	Less than 0.03%.
Harmonic Attenuation	Within 0.5dB (2nd and 3rd harmonics).
S/N (Noise) Measurement	
Range	0 to 70dB below the reference level.
Input Voltage Range	0.35 to 30Vrms.
Level Measurement	
Voltage Range	1mV to 300Vrms in 12 ranges; minimum reading, 0.1mV.
Accuracy	±5% of full scale.
Frequency Range	20Hz to 200kHz.
Highpass Filter	Cutoff at 500Hz; 6dB/octave attenuation.
Monitor Output	Approx. 1Vrms at full scale reading; output impedance, approx. 1kΩ.
Operating Temp. Range	0° to 40°C.

Power Supply	At specified voltage ±10%, 50/60Hz; input taps at 100, 115, 200, 215, and 230V approx. 5VA.
Size and Weight	150(H) x 300(W) x 250(D) mm; 5kg.
Accessory, furnished	Input cord w/clips and double plug.

1.3 Panel Functions

A. Front Panel, Fig. 1-1.

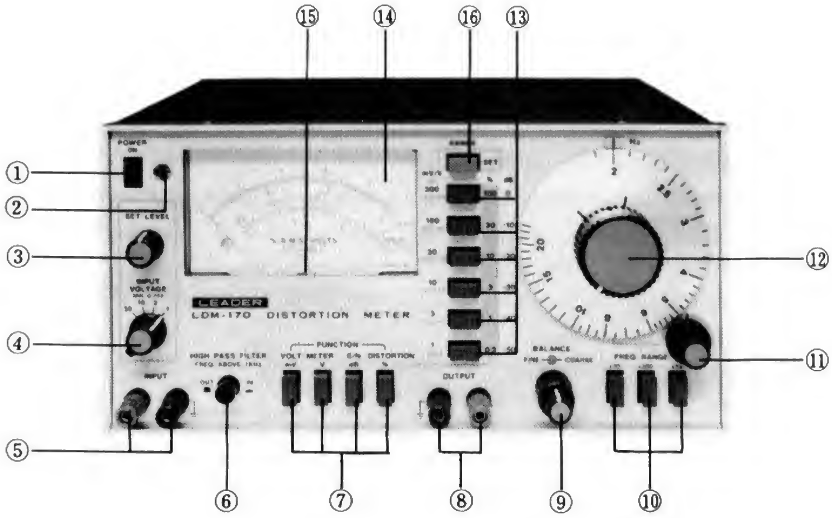


Fig. 1-1 Front panel controls.

1 POWER switch: Turns on the AC input for operation.
2 Pilot lamp: Indicates when the power is on.
3 SET LEVEL control: Used in setting the reference input level for distortion and S/N measurements.
4 INPUT VOLTAGE switch: Sets the input voltage range for distortion and S/N measurements.
5 INPUT terminals: For connection to the test circuit output.
6 HIGH PASS FILTER switch: For cutting out the low frequency noise (AC hum, etc.); used in distortion and S/N measurements, particularly in the 2 to 20kHz range.
7 FUNCTION switches: For selection of different uses of the instrument:

VOLT METER
- mV: For inputs less than 300mVrms.
- V: For inputs in the 0.3 to 300Vrms range.

S/N dB: For noise figure measurements.
DISTORTION %: For distortion measurements.

8 OUTPUT terminals: For waveform monitoring with an external scope, etc.; output proportional to the meter indication.

9 BALANCE control: For nulling the fundamental during distortion measurements; outer and inner knobs respectively for coarse and fine adjustments.

10 FREQ. RANGE switches: Selects the range of the fundamental when measuring distortion:

×10: 20 – 200Hz
×100: 200 – 2000Hz
×1k: 2 – 20kHz

11 Fine tuning adjuster: For fine tuning of the input frequency.

12 Frequency dial, Hz: Calibrated from 2 to 20, with overlaps; actual frequency depends on the FREQ. RANGE switch setting; two-speed control.

13 RANGE switches: For selecting the full scale meter ranges for the different functions.

14 Mechanical zero adjuster: For setting the meter pointer at 0 (at left) with AC power at off.

15 Meter: With two scales for voltage and %, and a scale for dB (decibel), referred to 0dB = 1Vrms.

16 CALibrate switch: Used when setting the input level reference for distortion and S/N measurements.

B. Rear panel, Fig. 1-2.

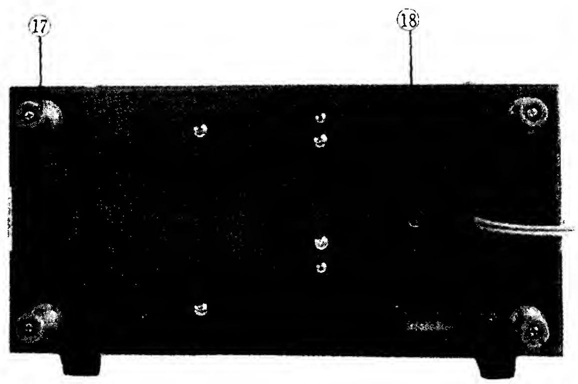


Fig. 1-2 Rear panel items.

17 Standoffs: For AC cord storage, or for vertical positioning of the instrument.

18 FUSEholder: For the AC line fuse.

SECTION 2 OPERATION

2.1 Distortion Measurement

2.1.1 Preliminary Notes

a. The input voltage should be in the 0.35 to 30Vrms range. For inputs in the 0.1 to 0.3Vrms range, refer to

Sect. 2.1.4.

b. Do not apply voltages greater than 125V, AC or DC, across the INPUT terminals.

c. If DC voltage is present in the load circuit, use a blocking capacitor with suitable voltage rating in series with the "hot" lead, typically 0.5μF at 20Hz, and correspondingly smaller capacitances at higher frequencies.

2.1.2 Preparation

1. Set the POWER switch at on. Allow a few minutes for warmup.
2. Initial settings:

   SET LEVEL at full counterclockwise.
   INPUT VOLTAGE switch at 30V.
   HIGHPASS FILTER switch at OFF.
   DISTORTION switch at on.
   BALANCE
   Fine tuning) at midposition, see Fig. 2-1.
   The "Frequency Dial" and "Range" must be set to the frequency of the input signal.

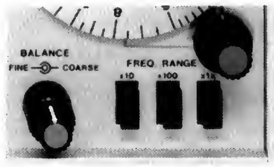


Fig. 2-1

3. Connect the input cord from the INPUT terminals to the test circuit output. An example is shown in Fig. 2-2.

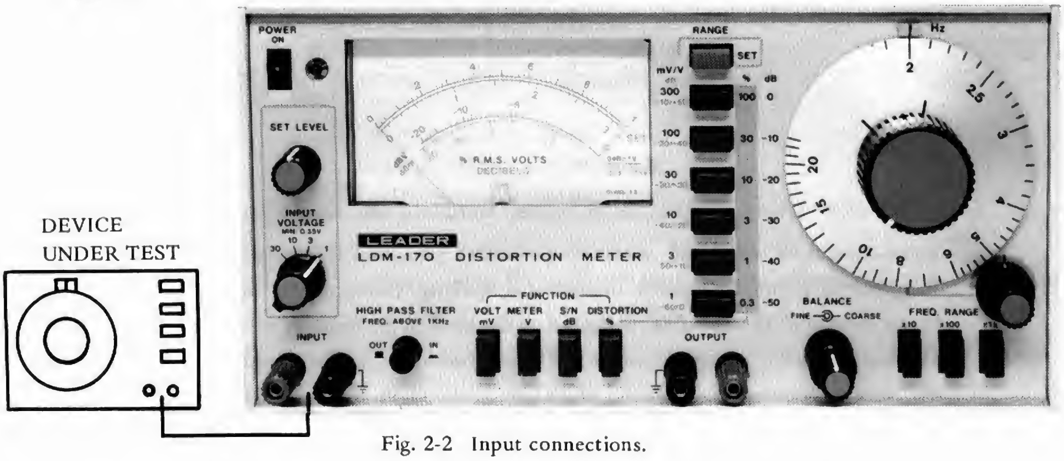


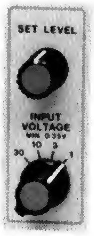
Fig. 2-2 Input connections.

4. Input voltage adjustments:

   Press the "V" switch of VOLT METER
   Press the 30V ... 1V switch to measure the test input voltage. The proper INPUT VOLTAGE switch setting can be determined by referring to TABLE 2-1.

TABLE 2-1

INPUT RANGE	INPUT VOLTAGE SWITCH SETTING
0.35 – 1V	1
1 – 3V	3
3 – 10V	10
10 – 30V	30



5. After the INPUT VOLTAGE switch has been set, press the CAL switch and distortion switch.
6. Advance the SET LEVEL control for full scale reading on the meter NOTE: This step is required when the input voltage has been altered.
7. Press the 100% switch of RANGE.

2.1.3 Tuning and Balancing Adjustments

A. Tuning the fundamental frequency:

The FREQ. RANGE switch is set for the range in use; refer to TABLE 2-2.

TABLE 2-2

FUNDAMENTAL RANGE	FREQ. RANGE SETTING
20 – 200Hz	×10
200 – 2000Hz	×100
2 – 20kHz	1k

A two-speed drive, direct and vernier (slow-motion), is used for the tuning.
In operation, rotate the knob so that the dial marking "over-runs" the test frequency by about 15 degrees in one direction. Then for fine tuning, rotate the knob in the opposite direction.
The knob rotation is approximately 300 degrees within the ±15 degree limits, or about 80% to 120% of the "center frequency". Using the white line on the knob, the vernier drive will be within the two short black lines on the dial, regardless of the dial position. Outside these limits, direct drive takes place.

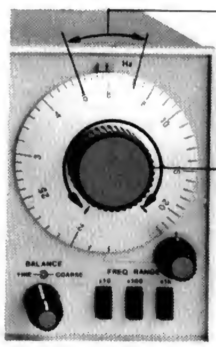


Fig. 2-3

An example is shown in Fig. 2-3. If the fundamental is at, say "6" (60Hz, 600Hz or 6kHz depending on the range), the dial is initially set at "5" or "7" by over-running the "6" marking. The vernier drive will cover the range between 5 and 7.

Adjust the knob in the vicinity of "6" until the meter reading is a minimum.

Next, press the 30% and 10% switches in order and readjust the tuning until the meter dips to a minimum.

At the 1% range, use the fine tuning adjuster for the same condition.

The sensitivity is increased by pressing the 3%, 1%, 0.3% range switches.

B. Balancing Adjustments,
After the tuning adjustments, use the BALANCE knobs, outer and inner, for maximum dip on the meter. Repeat the adjustments in the order – tuning (vernier and fine) – BALANCE – tuning – BALANCE – until there is no further dip in the meter reading.

C. The distortion value is the meter scale reading and application of the proper scale multiplier, see TABLE 2-3.

TABLE 2-3

RANGE	SCALE	MULTIPLIER
100%	0 – 1	100
30	0 – 3	10
10	0 – 1	10
3	0 – 3	1
1	0 – 1	1
0.3	0 – 3	0.1

NOTES: 1. For measurements in the 2 – 20kHz range, set the HIGH PASS FILTER switch at on. This will cut out the low frequency noise components such as "AC hum", etc.

2. Whenever the test frequency and/or the input voltage have been altered, it is necessary to renew the calibration as given in Steps 4, 5, and 6 given in Sect. 2.1.2.

2.1.4 Measurements at 100 – 300mVrms input

1. Switch settings:
   RANGE at 30%.
   S/N of function at on.

   INPUT VOLTAGE at "1".
2. Adjustments:
   a. SET LEVEL control for full scale meter reading.
   b. Distortion of function at on.
   c. After the tuning and balancing adjustments, press the RANGE switches for the measurement.
   d. It is necessary to convert the ranges as shown in TABLE 2-4.

TABLE 2-4

RANGE	SWITCH	SCALE
FOR 10% f.s.	Use: 30%	0 – 1
3%	10%	0 – 3
1%	3%	0 – 1
0.3%	1%	0 – 3

2.1.5 Use of an Oscilloscope

The use of a sensitive general purpose scope, preferably the dual-trace type, is recommended. Tuning and balancing adjustments will be speeded up; furthermore, waveforms of distortion components can be observed. Typical connections are shown in Fig. 2-4.

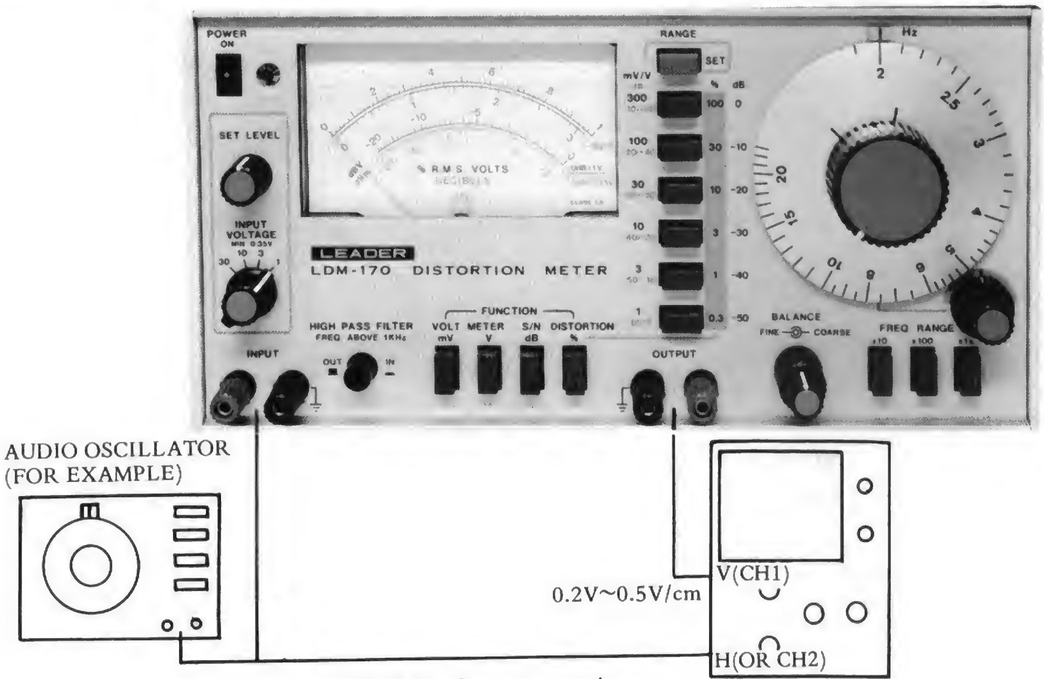
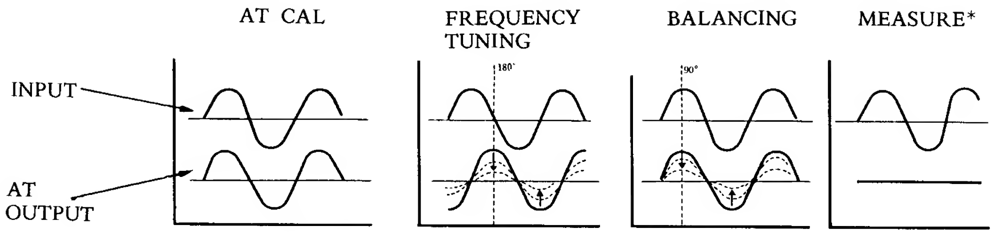


Fig. 2-4 Scope connections.

2.1.5-A. Direct connection

1. Connect leads from the OUTPUT terminals to the vertical input of the scope.
2. Set the CAL switch at on, after the INPUT VOLTAGE setting.
3. Set the scope controls to display two or three cycles. Set the CAL switch at off.
4. Note the trace amplitude during the tuning and balancing adjustments. The trace height will be lowered when the balance condition is approached, see lower traces in Fig. 2-5. This is the same condition as when noting the meter indications.



* After repeated adjustments; ideal condition shown.
Fig. 2-5 Use of waveform display.

2.1.5-B. Dual-trace method

With the OUTPUT connections as in A above, connect the signal from the test device to the other channel input (in parallel with the INPUT leads); refer to Fig. 2-4.

The upper traces in Fig. 2-5 is for the signal under test; the lower traces are during the adjustments.

2.1.5-C. Lissajous patterns

Set the sweep (timing) switch for external horizontal input. Connect the signal from the test device to the horizontal input (in parallel with the INPUT leads); refer to Fig. 2-4.

Adjust the horizontal gain for suitable trace length.

At the CAL setting, the trace will be a slanted line, see Fig. 2-6.

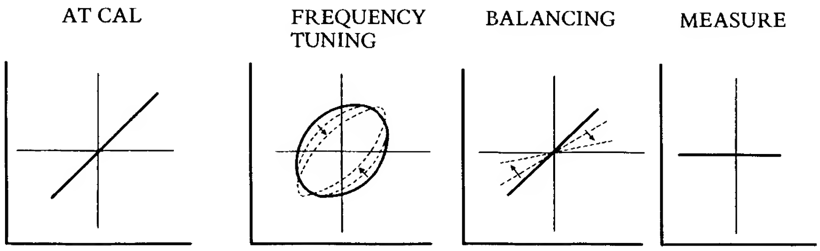


Fig. 2-6 Using the Lissajous pattern.

When the RANGE switch and tuning/balance controls are adjusted, the trace will vary from an ellipse to a "straight" horizontal line as shown in the figure.

With these types of patterns, different characteristics can be detected as shown in Fig. 2-7.

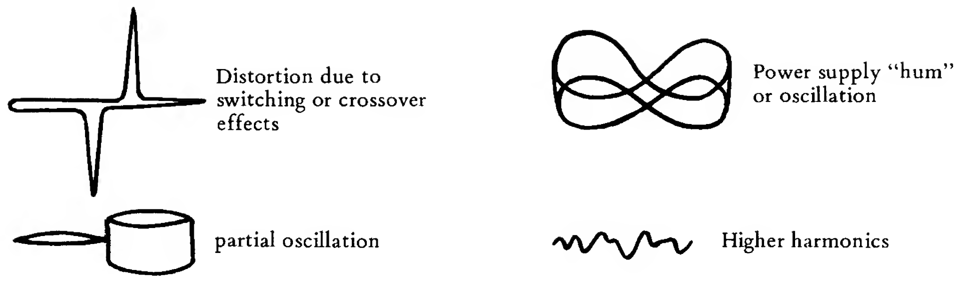


Fig. 2-7 Distortion observed with Lissajous patterns.

2.1.6 Examples of Measurements

2.1.6-A. Oscillator distortion

When measuring the distortion in audio amplifiers, it is advised that the oscillator (source) distortion be measured. This step will permit more accurate distortion measurements.

Typical examples of measurements are shown in "A" and "B" of Fig. 2-8.

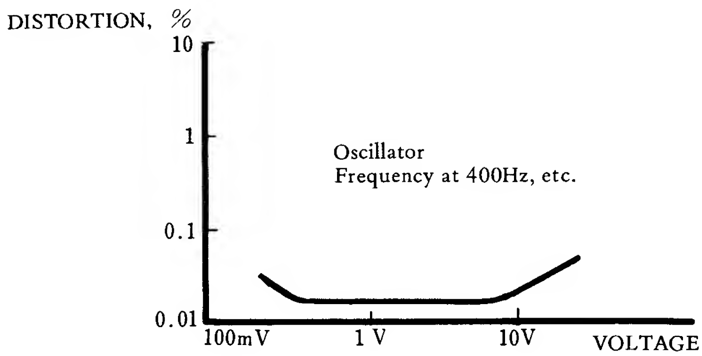


Fig. 2-8 A : Output VS. distortion.

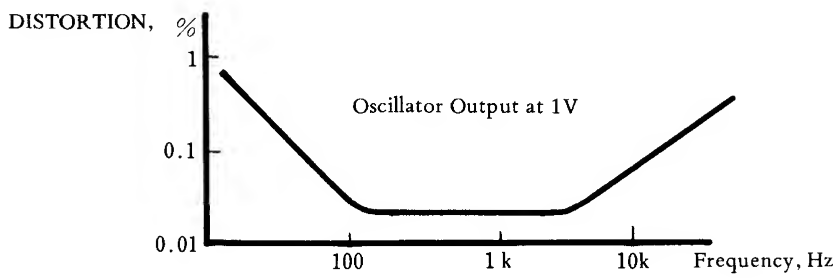


Fig. 2-8 B : Frequency VS. distortion.

2.1.6-B. Amplifier distortion

The distortion VS. output voltage at three selected frequencies is shown in "A" of Fig.

An example of distortion characteristics at three selected frequencies is shown in "A" of Fig. 2-9, in "B" of the same figure, the overall distortion characteristic is shown.

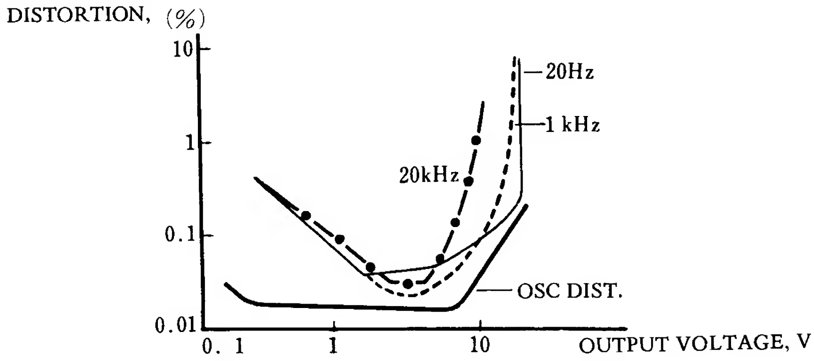


Fig. 2-9 A : Amplifier output VS. distortion.

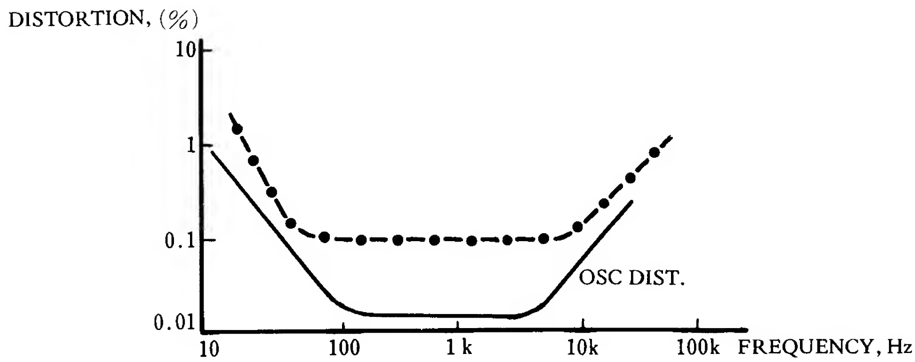


Fig. 2-9 B : Frequency VS. distortion.

2.1.6-C. Effect of oscillator distortion

The lower curves (thick lines) in Fig. 2-9 (A and B) and represent the oscillator (source) distortion. For accuracy in amplifier measurements, especially at low values, it is necessary at test frequencies and output levels to take this into account. This step is required since the distortion meter indicates the total distortion of the amplifier and oscillator outputs.

The actual amplifier distortion is calculated from the relation –

$$D_A = \sqrt{D_M^2 - D_{OSC}^2} \tag{1}$$

where D_A = Amplifier distortion in %.

D_M = Distortion meter indication in %

D_{OSC} = Oscillator distortion in %

In simplified form, (1) may be expressed by –

$$D_A = D_M\sqrt{1-\left(\frac{D_{OSC}}{D_M}\right)^2} = D_M \quad K \qquad (2)$$

The factor, K, for (2) is listed in the following table.

FACTOR "K" for (2)

D_{OSC}/D_M	K	D_{OSC}/D_M	K
0.90	0.436	0.60	0.80
.85	.526	.50	.866
.80	.60	.40	.916
.75	.661	.30	.954
.70	.714	.20	.978
.65	.758	.10	.995

In general, when the oscillator distortion is less than, say, 1/5 of the amplifier distortion, the meter indication can be used without correction

2.2 S/N Measurement

S/N is the ratio of S (= signal + noise) to the noise at the output of an amplifier.
With the LDM-170, measurement is made at the same input levels as in distortion measurement, i.e.,0.35 to 30Vrms.
In general, the S/N is measured at a specified level (at maximum) at the test circuit output.
Typical equipment connections are shown in Fig. 2-10.

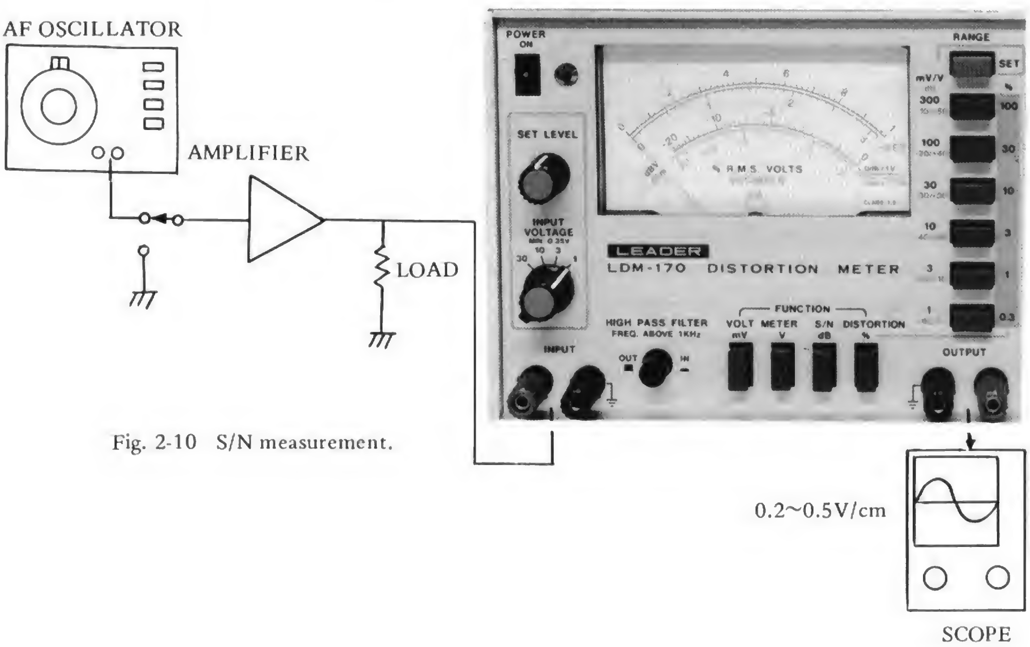


Fig. 2-10 S/N measurement.

1. Control settings:
   INPUT VOLTAGE switch at 30.
   S/N switch of function at on.
   CAL switch of RANGE at on.
2. Adjustments:
   Amplifier output to specified level, or voltage.
   INPUT LEVEL switch and SET LEVEL control for full scale reading on the meter.
   Oscillator frequency as required, 400Hz, etc.
3. Disconnect the oscillator output and short the amplifier input to ground.
4. Press the RANGE switches, −10dB, −20dB, etc., as required for a reading at least above 30% of full scale (except when the −50dB range is used for low values).
5. For the S/N value, in dB, add the meter reading to the RANGE marking in −dB, and change the minus sign to +, see TABLE 2-5.

TABLE 2-5

RANGE SWITCH SETTING	S/N RANGE
−10dB	10 to 20dB
−20	20 to 30
−30	30 to 40
−40	40 to 50
−50	50 to 70

Example: Meter reading −6
RANGE switch −40
−46

The S/N is 46dB.

NOTES: 1. For direct noise voltage measurement, press the mV switch of VOLTMETER and use the RANGE switches.
2. With the OUTPUT terminals connected to the scope input, it is possible to determine the nature of the noise waveform.
3. To suppress the AC hum and other low frequency noises, by about 20dB, press the HIGH PASS FILTER switch; release when not in use.

2.3 Voltage Measurement

2.3.1 General

The voltage range, 1mV to 300Vrms at full scale, is covered in 12 ranges. The input impedance is 1MΩ shunted with less than 50pF. The frequency range is 20Hz to 200kHz.

2.3.2 Operation

1. Switch settings:

   VOLTMETER of function at mV or V.

   RANGE depending on the input voltage. If not known, set at a high range and work down.

   HIGH PASS FILTER at off.

2. Connect the input cord, or leads, to the INPUT terminals.

3. Set the RANGE switch so that the reading is at least above 30% full scale (except when the 1mV range is used).

   The scales and multipliers for the ranges are given in TABLE 2-6.

TABLE 2-6

RANGE SWITCH SETTING	SCALE	MULTIPLIER FOR mV or V
300	0 – 3	100
100	0 – 1	100
30	0 – 3	10
10	0 – 1	10
3	0 – 3	1
1	0 – 1	1

4. The dB scales can be used to indicate the input level referred to 0dB = 1V as dB V or 0dB = 0.775V as dBm. The ranges are given in TABLE 2-7.

Use only dBV scale for the S/N measurements

RANGE			dBm	dBV
VOLTAGE		dB	(0dB - 0.775V)	(0dB = 1V)
300	V	+50	+30 ~ +52	+30 ~ +50
100	V	+40	+20 ~ +42	+20 ~ +40
30	V	+30	+10 ~ +32	+10 ~ +30
10	V	+20	0 ~ +22	0 ~ +20
3	V	+10	–10 ~ +12	–10 ~ +10
1	V	0	–20 ~ + 2	–20 ~ 0
300	mV	–10	–30 ~ – 8	–30 ~ –10
100	mV	–20	–40 ~ –18	–40 ~ –20
30	mV	–30	–50 ~ –28	–50 ~ –30
10	mV	–40	–60 ~ –38	–60 ~ –40
3	mV	–50	–70 ~ –48	–70 ~ –50
1	mV	–60	–80 ~ –58	–80 ~ –60

SECTION 3 PRINCIPLE OF OPERATION

3.1 Distortion Measurement

The harmonic distortion meter is used to measure the magnitude of the harmonics ($2f_o$, $3f_o$ ...) relative to the fundamental signal frequency, f_o. In simplified form, the distortion in % (percent) is given by the relation –

$$\text{Distortion} = \frac{\text{Level of harmonics}}{\text{Level of (fundamental + harmonics)}} \times 100$$

Typical distorted waveforms are shown in A and B of Fig. 3-1.

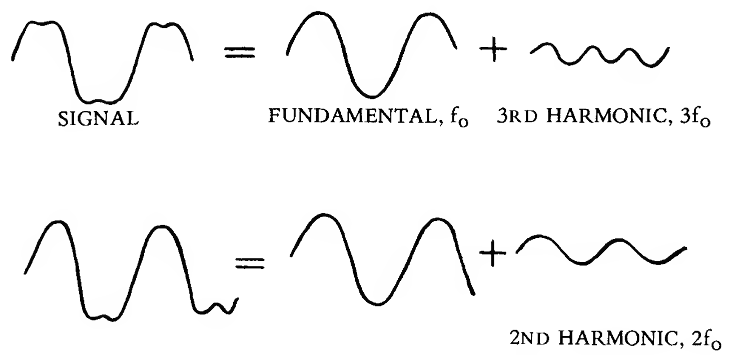


Fig. 3-1 Distorted waveforms.

In the LDM-170, the fundamental input voltage is used as the reference level (CAL operation). Then the fundamental suppression network is switched in, leaving only the harmonics whose level in % is indicated, see Fig. 3-2.

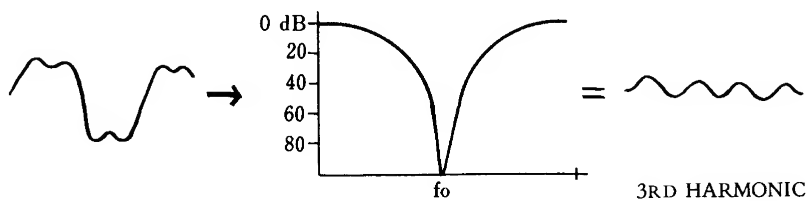


Fig. 3-2 Fundamental suppression.

The simplified block diagram is shown in Fig. 3-3.

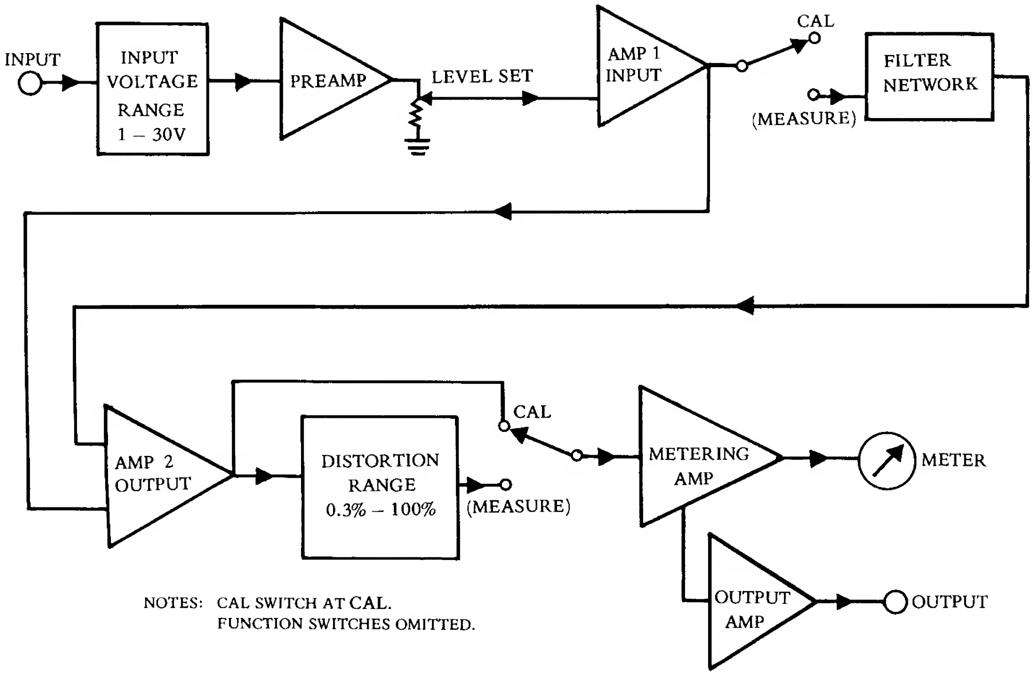


Fig. 3-3 Distortion measurement: Simplified block diagram.

3.2 S/N Measurement

The input signal from an amplifier at a specified frequency (400Hz, 1kHz, etc.) is used to set the reference level.
The noise level is determined by removing the signal source and shorting the amplifier input.
In the LDM-170, the ratio S (signal including noise) to noise, N, is calibrated in terms of dB (decibel), see Fig. 3-4.

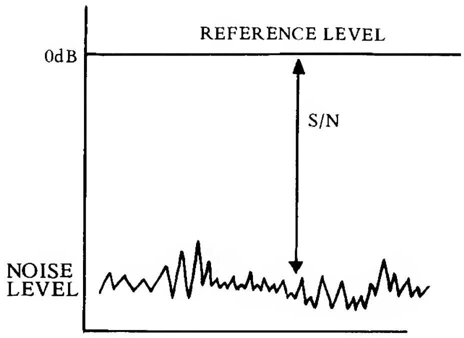


Fig. 3-4 S/N measurement

The measurement is made in similar manner as that for distortion but with the filter network out of circuit. The simplified block diagram is shown in Fig. 3-5.

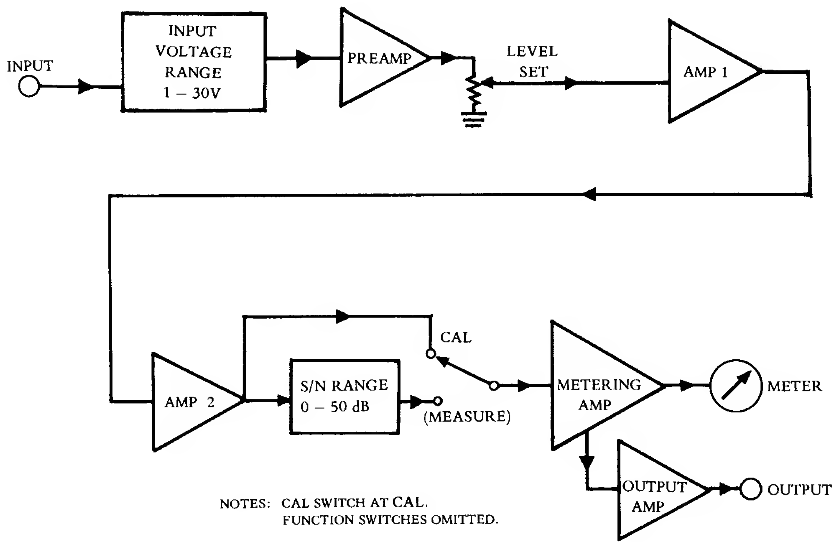


Fig. 3-5 Simplified block diagram for S/N measurement.

3.3 Voltage Measurement

The amplifier system for distortion and S/N measurements is used for this purpose.

The normal range is 1mV to 300mV at full scale and with use of an input attenuator, the range is multiplied by approximately 300 times for coverage up to 300Vrms at full scale.

The simplified block diagram is shown in Fig. 3-6.

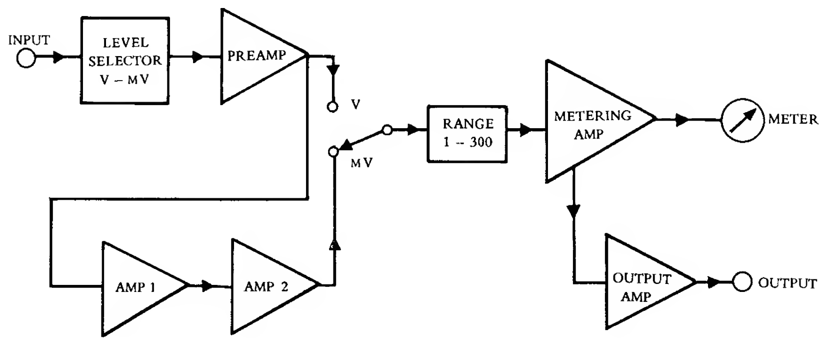


Fig. 3-6 Simplified block diagram for voltage measurement.

The filtering characteristic is shown in Fig. 3-7. It is effective in eliminating low frequency noise, below 2kHz, (HIGH PASS FILTER switch at on), when used in distortion and S/N measurements.

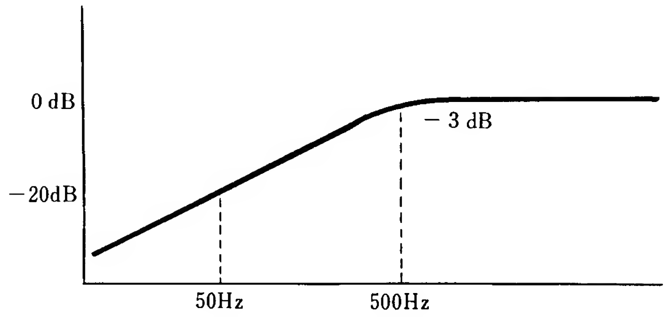


Fig. 3-7 High-pass filter characteristic.

3.5 DC Power Supply

A regulated supply furnishes the +18V required for its operation. The circuit uses a fullwave rectifier and a conventional regulator.